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Jack R. Borsting Interview (MORS)

Borsting, Jack R.

ORAL HISTORY DISCLAIMER

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INTRODUCTION

Dr. Jack R. Borsting, FS was MORS President 1970–1971. This article includes both an interview with Dr. Borsting as well as a transcript of the Heritage Session at the 72nd MORS Symposium at the Naval Postgraduate School (NPS), Monterey, California, 23 June 2004. The 72nd Heritage Session featured Jack Borsting and Wayne Hughes, FS. Wayne was one of Jack's premier students at NPS and his oral history was published in MOR, Volume 9, Number 4, 2004.

BOB SHELDON: We are located in the historic offices of Herrmann Hall at the Naval Postgraduate School at Monterey, California. Mike Garrambone and I are here with Dr. Borsting to attend the 72nd MORS Symposium. Dr. Borsting, would you start by telling us where you were born and raised?

JACK BORSTING: I was born in Portland, Oregon on 31 January 1929 and raised in Portland Oregon.

BOB SHELDON: Who were your parents and how did they influence you in your studies?

JACK BORSTING: My father's name was Johannes, or John, Sorenson Borsting. My mother's name was Ruth Marie Nelson. My father was an immigrant from Denmark with a fifth grade education in Denmark. His brother got him to come to this country and he later became a butter maker and then half owner of a creamery. My mother's parents were Swedish. They immigrated and she was born in this country. To support her parents, she had to quit high school at age 16. My parents wanted me to get as much education as possible. They didn't have much education, but they encouraged me. They told me I was going to college when I was in grade school. They didn't push me, but they wanted me to go to college. I specialized in mathematics because it was easy for me.

MIKE GARRAMBONE: What high school did you go to and what did you study?

JACK BORSTING: I went to elementary and high school in Portland. I took a general pre-college course in high school. I went to Franklin High School in Portland, Oregon and took as much mathematics as I could. I wish I had taken some foreign languages in high school. This was a big mistake. I ended up taking two years of German in college, but it would have been much better if I had taken a language earlier. I went to Oregon State University as an undergraduate and received my masters and Ph.D. from the University of Oregon.

BOB SHELDON: Did you have an early inclination towards mathematics?

JACK BORSTING: When I went to college I wanted to be an electrical engineer. After little less than one semester, I became tired of writing tedious lab reports and having my fraternity brothers copy them and got A's and I got B^+'s because mine were not neat enough. At that point, I decided to switch to mathematics, and so all of my degrees are in mathematics.

BOB SHELDON: What kind of mathematics did you focus on?

JACK BORSTING: I have always had an interest in statistics and probability theory, but my doctorate is actually in abstract mathematics, but with an emphasis on probability theory and statistical theory.

BOB SHELDON: Did you have any notable professors?

JACK BORSTING: I had a lot of notable professors. At the master's level and starting the doctorate, there was Will Dixon and Frank Massey, who went on to U.C.L.A. and worked in Biostatistics. They taught a very good mix of applied and theoretical statistics. I did my doctoral work under Herman Ruben, who was simply a genius.

BOB SHELDON: As you were going through school, how did you view your job opportunities?

JACK BORSTING: When I was in graduate school, I thought about becoming an actuary, and I took the first three actuary exams and passed them. Some actuarial companies knew I was working on my doctorate and they wanted to hire me. But they wouldn't pay any more money if I got my Ph.D. So I decided it wasn't worth it and I

Military Operations Research Society (MORS) Oral History Project Interview of Jack Borsting, FS

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would go into industry as a mathematician when I got my doctorate.

BOB SHELDON: What was your first job in industry?

JACK BORSTING: I didn't go right into industry. My first job after my doctorate was in academia. I turned down all my industrial offers, and applied to two academic institutions. One was the University of Oregon Medical Dental School and the other was the Naval Postgraduate School. I had to decide between these two offers and I chose to go to the Naval Postgraduate School.

BOB SHELDON: Who recruited you from NPS?

JACK BORSTING: That's a good question. I guess it was the Chairman of the Mathematics Department.

BOB SHELDON: Were they looking for mathematicians and statisticians?

JACK BORSTING: They were looking for a statistician, and by chance, I was attending a meeting at NPS as a graduate student. I rode down on a bus from Palo Alto with a meteorology professor and he told me all about the school. I sent off a resume and we started talking and I ended up at NPS. One thing I should mention in between my masters and doctorate degrees; I went into the Air Force and spent two years as an Air Force officer.

BOB SHELDON: What year did you go into the Air Force?

JACK BORSTING: It was 1954 to 1956. I spent two years as an engineer working on "practice" nuclear weapons for the Air Force at Kirtland Air Force Base in Albuquerque, New Mexico. Then after the two years, I came back and finished my doctorate in Oregon.

BOB SHELDON: Were you working for AFOTEC, the Air Force Operational Test and Evaluation Center?

JACK BORSTING: I'm not sure about AFOTEC. I worked in what was called the Development Directorate at Kirtland. We worked with practice nuclear weapons. I was a project officer working with practice nuclear weapons and one of the more interesting projects was trying to develop a practice unit for the Genie, which was an air-to-air atomic warhead rocket for the F-102. The rocket was not supposed to hit the target, because it was an atomic warhead rocket. It was designed to blast out the target; the practice unit was a smaller caliber rocket. One of the difficulties in developing a practice weapon was that you were not supposed to hit the target. You were just supposed to be in the vicinity. We also wanted a cheap practice unit.

Another project was to develop a sub-caliber bomb that simulated an atomic weapon that was carried externally on the F-86 fighter. We found that the Navy had developed a practice unit called the Aero 5A. The Aero 5A carried six Mark 76 practice bombs whose ballistics simulated the parent weapon.

BOB SHELDON: Were you using statistics or engineering principles?

JACK BORSTING: I didn't use any statistics. Basically, I was just an applied engineer at Kirtland using basic engineering principles. I had other projects too.

BOB SHELDON: Was your test a success?

JACK BORSTING: Yes, we developed, we tested, and we fixed the Aero 5A and made it so it would drop one unit at a time. Remember the project was to develop a sub-caliber practice unit for an atomic warhead bomb. It was the Aero 5A that needed work and it had a Mark 76 practice unit that simulated one of these units that was carried externally on an F-86 fighter. The flight maneuver would release the bomb from the aircraft and it turned out the Mark 76 simulated the right ballistics. The Aero 5A did not initially work. It either dropped one unit at a time, or six of them. So we ended up fixing it and the Air Force purchased the unit from the Navy. This was a low altitude bombing system. As I mentioned earlier I also was the project officer on the atomic warhead practice unit for the Genie missile, which was an atomic air-to-air missile that was delivered from the F-102. I had the job of developing an inexpensive practice unit. The contractor on the practice unit was Douglas Aircraft, and it did develop a sub-caliber unit that did simulate the ballistics of the parent atomic air-to-air rocket. We presented it at the Pentagon to the Air Force. After I left the Air Force, they decided it was too expensive to buy and they did not buy the practice unit. The Genie on the other hand was certainly fitted out for the F-102.

BOB SHELDON: What made you decide to enter the Air Force?

JACK BORSTING: I had an ROTC commission.

BOB SHELDON: Was that a four-year ROTC scholarship?

JACK BORSTING: No. I had two years of undergraduate ROTC at Oregon State; everybody was required to take it. I then decided to take advanced ROTC, but it was not on a scholarship. The Air Force did not give scholarships. I had a scholarship to go to undergraduate school, but the Navy was the one who gave scholarships at that time, that is, Air Force ROTC. I got my commission in the Air Force and I received a deferment for a while, but I ended up being called into the Air Force for a two-year tour.

BOB SHELDON: So you came out after two years and went back to graduate school?

JACK BORSTING: Yes.

BOB SHELDON: Was there anything else of value from your initial Air Force experience? Did you learn a tester's attitude?

JACK BORSTING: I had a tester's attitude, but I also learned to deal with industry, because we had projects with industry. As a young lieutenant I learned to work with other Air Force officers and I obtained project management experience. I had several projects where I was the project leader. That was a lot of responsibility for a young lieutenant who was inexperienced.

BOB SHELDON: So you went back a more mature graduate student?

JACK BORSTING: Oh yes. I went back a much more mature graduate student.

BOB SHELDON: Let's jump forward in time to when you decided to go to the Naval Postgraduate School. How many other faculty members were in your department?

JACK BORSTING: I am not sure. There were two other statisticians and I don't remember how many mathematicians. One of the reasons I came to the Naval Postgraduate School was because it had an operations research master's degree. It was started probably about the time the move from Annapolis to Monterey took place around 1951. It was an interdisciplinary operations research program that was a joint degree between the mathematics department and the physics department.

BOB SHELDON: What courses did you teach initially?

JACK BORSTING: The first course I taught was a course in vector analysis and then I taught probability theory and statistics, and then various other types of statistics courses.

BOB SHELDON: Did they allow you time to do some research?

JACK BORSTING: Yes. The teaching requirement was a little high at NPS, which was disappointing at first, but I did do some research.

BOB SHELDON: What was your research topic?

JACK BORSTING: Some of my early research was in applied meteorology. I was trying to predict anti-cyclones and published some papers in the Journal of Applied Meteorology.

BOB SHELDON: Was this related to your Ph.D. dissertation?

JACK BORSTING: My Ph.D. dissertation was in theoretical probability theory and was not related at all.

BOB SHELDON: What year did you start teaching here and how many students did you have in your typical classes?

JACK BORSTING: It was 1959, and I would say we had about 35 to 40 students in the basic classes.

BOB SHELDON: How did you like your students?

JACK BORSTING: The students at the NPS were very motivated. They worked very hard. Their background may have not been great to do some of the quantitative work. They would have to catch up, but they were really motivated to work hard. They also expected the professor to work hard. My role models in teaching at the University of Oregon were not great. They were kind of sloppy teachers. I was better than they were, but I don't think I was very good compared to what I should have been. The students at NPS in their course evaluations made some good comments. I listened to the students comments and became a much better teacher. I eventually became an excellent teacher here, but I wasn't that great initially.

BOB SHELDON: Did you have any notable students?

JACK BORSTING: One of the early OR students who graduated from here was a flag officer, whose name was Conrad Abhau. There were other students who made flag officer rank in the early years of the program. One was Tom Hughes, who made three stars. In his last assignment, he headed the logistics department of the Navy. He is now a visiting chair professor at Monterey. Another student was Joe Metcalf, who was retired as a three-star. He ended up heading the Granada operation. Another early student that made flag was Bob Ailes. One of my early students who I kept in touch with was Wayne Hughes. He had several classes from me.

BOB SHELDON: How many different classes were you teaching?

JACK BORSTING: I taught a lot of the basic probability and statistics courses, plus I taught a matrix algebra course. I also taught an advanced applied statistics course. Another early student in Wayne's class was Jim Roche. He made Captain, got out of the Navy, and had a very successful tenure at Northrop Grumman. He could have made Admiral, but he decided to get out when he was a Navy Captain. He later became Secretary of the Air Force. I am sure there were others who I can't remember at the moment.

BOB SHELDON: You were teaching statistics before we had computers and high-powered calculators. Were your students able to keep up with pencil and paper calculations to do statistics?

JACK BORSTING: We did have calculators, but the school also installed the first Control Data Computer off the assembly line. The Control Data 1604 was installed at the school so the students had the use of a fast mainframe. Of course, they were using punch cards and they did a lot of thesis work programming in FORTRAN and other languages. It wasn't as bad as when I went to school. I had slow calculators. The school (NPS) has been pretty much of a leader in computing facilities. The Control Data 1604 was a very fast computer at that time, in 1961. One of its problems was it did not have the software that an IBM machine had.

BOB SHELDON: How much space did that first computer take up?

JACK BORSTING: Quite a bit of space. I am trying to remember where it was installed. I can't remember where, but it did take up a very good size room with all the disc drives, the CPU, and auxiliary equipment. One of the frustrating things about early computers I do remember. I wanted to get my students manipulating data on the computer and it turned out that the biostatistics group at U.C.L.A., my former professors Dixon and Massey, had developed what was called at that time the bio med programs. They were applied statistical programs that could be run on the Control Data 1604. So I got these programs here, and I was trying to show my students how you could manipulate data and change the regression line. For example if you take out outliers the regression lines may change significantly. I did get this type of material on the 1604, but the only problem was whenever I wanted to run it for students, the computer would be down. So I ended up taking a movie of it and showing them the movie. The early days of computers were frustrating. It's still frustrating at times, and you can only do so much with a computer.

BOB SHELDON: When you were generating your lesson plans, did you get any help from the Navy for what parts of the curriculum they wanted to emphasize in statistics?

JACK BORSTING: Sure. Now let me go a little ahead in time and I will bring that up when I talk about the Operations Research Department, which is very germane to what you want us to talk about today. In approximately 1962, a professor in the Math Department by the name of Tom Oberbeck talked the Provost and the Superintendent into forming an Operations Research Department. He was in the Math Department. It turned out that I decided to stay in the Math Department. The other principals in the Operations Research program were Professor Torrance and Professor Cunningham. Professor Torrance was a mathematician, Professor Cunningham was a physicist. They decided to stay in their respective departments. So, Tom Oberbeck had to recruit faculty members for this fledgling department. Then in 1964, he got into a fight with the Superintendent and Provost. He quit, expecting to be

asked back. I think they were happy to see him leave because he was a thorn in their side. In June of 1964 I got a call to meet with the Superintendent in his office. He said he would like me to become the Chairman of the OR Department and move from the Math Department to the Operations Research Department. This was a surprise, as I was a young associate professor at the time. I was not ready for a management position. And I said, "How long do I have to decide?"

BOB SHELDON: Were you tenured?

JACK BORSTING: Yes. I was tenured. He said, "24 hours." It was about five o'clock then, and he said, "See me back here the next day at five." So I went home and talked to my family. I also talked to Commander Paul Wolff, from the Fleet Numerical Weather Facility. I worked a lot with him on applied meteorology problems. He told me that the OR program was the most important program here for the Navy and I would be a fool not to accept. The Superintendent had also told me that. He said, "This is the most important program at the Naval Postgraduate School and I want you to chair it". So I came back at 5 o'clock the next day and told him I would chair the department. This presented an interesting challenge in my career in that I did not know that much about operations research.

BOB SHELDON: How old were you at the time?

JACK BORSTING: I was about 35 and I still wasn't a full professor. The market for operations research faculty members was very tight because a lot of schools were starting OR programs and there was no nucleus to build from in the department. There were a couple of people, two faculty members, Professor Shudde and Professor Andrus and that was basically it. In the Math Department, working with the math chairmen, I had recruited Professors Read, Zehna, Woods, and Larsen. They decided to come to the OR department and work with me.

BOB SHELDON: Was that Professor Bob Read that is just retiring?

JACK BORSTING: Yes. I recruited him. I was doing a lot of recruiting in the Math Department, because the two statisticians that were here when I came had both left. One went to San Francisco State and the other went to Oregon State, so we had to recruit some new statisticians. We got a good group and they moved over to the OR Department which was very helpful to me in building the department. In fact, I went on the road and recruited Steve Pollack at MIT, who stayed at the school for about six years and then went to Michigan. I also recruited Dave Schrady from Case Western and he is still here. I recruited faculty from Purdue, Claremont, and the University of Illinois. Also, I didn't know that much about operations research and I had to pick it up on the fly. I started going to MORS meetings at that time and also started attending ORSA and TIMS meetings as well.

BOB SHELDON: This is in 1964?

JACK BORSTING: Yes. I attended most of the Society's meetings. Also, there was a summer study I still remember the head of it, John Craven. It was a Polaris Missile System study, so I got myself involved in the study, which was at the Naval Postgraduate School. It was not originally involving the faculty at NPS, but fortunately I was involved. I learned about operations research by going to the various meetings and doing a lot of reading.

BOB SHELDON: What about the early MORS meetings?

JACK BORSTING: I went first to the Symposium and met people. Then I was asked to be on the Board of the Symposium. It wasn't a society at the time, so I said, "Sure, that would be a good idea." So I joined the MORS Board.

BOB SHELDON: What year was that?

JACK BORSTING: I'm not sure, it was probably mid 1960s. Then being on the Board, I got elected to be a Vice President. I can't remember which VP. Then I was elected President and served as President in 1971 and 1972. I was fairly active in MORS before I became President and after I became President, I went to the various symposiums, etc. It was an interesting time because MORS was trying to stay alive as is usually true with any fledgling organization. It hadn't established itself, and you had an Air Force, Army, and Navy sponsor, and people were worried. "Will the Navy pull out their funds? Will the Army keep sponsoring?" There had to be a lot of work to keep the

sponsors putting in funds to support the symposiums.

BOB SHELDON: Who asked you to be a MORS Director?

JACK BORSTING: It was somebody on the Board and I can't remember. I have to go back and look at the people on the Board then. I'm sure Tom Oberbeck, who I think was on the Board helped me. Tom took a sabbatical after he quit, and then came back and taught for a while, but then he left again.

BOB SHELDON: Was he at the Naval Postgraduate School?

JACK BORSTING: Yes. He died fairly young. I'm sure he helped me. Even though I replaced him, we had a very good relationship because he knew that I wasn't after his job. It was a complete surprise to me. So I'm not sure right now and I would have to go back and look at the MORS Board at that time. Art Stein was on the Board, but he wasn't the one. I am remembering some of the Presidents, but I'm not remembering who might have asked me. Anyway, I tried to get more faculty from the Postgraduate School's department active in MORS by giving papers, and being on the Board. When I went off the Board, there were other NPS faculty members on the Board. I think Dave Schrady was one of the first persons I got to be on the MORS Board.

BOB SHELDON: Were the MORS Symposia well run?

JACK BORSTING: Yes. At any meeting, you had some quality papers and you have some papers that were not quality. That is true of all the statistics meetings, the ORSA meetings, the TIMS meetings, the MORS meetings, etc. One of the reasons the quality of the papers isn't uniformly good is that people have to present a paper to go to the meeting and they are not refereed. Therefore you did have some not so good papers, but you had some really good papers. There were a few more plenary type papers at that time, where various sponsors from the Army and Air Force and Navy would give talks about what they were doing, and that was very helpful to me.

BOB SHELDON: When you picked up your Vice Presidential job in MORS, was that a major demand on your schedule?

JACK BORSTING: Not really. I think I'm a bit of a workaholic anyway. Also, most of the work was building the OR Department. At the same time, I was also active in ORSA. I got on the Education Committee in ORSA, probably because I was Chairman of the department here. Charley Flagel an OR professor was the chairman, and then I succeeded him as Chair of the ORSA Education Committee. We did some interesting things at that time. We started the visiting lecture program, where we had professors available to go talk at other universities that wanted an OR professional to speak. It was my idea to start the program. I was in charge of the program before I became Chairman of the Education Committee of ORSA. And, of course, we would also bring some military OR people to talk. Then I became even more active in ORSA. I ran for Council and was elected to the ORSA Council for a three-year term. Then I got asked to run for Secretary and I was elected as Secretary of the Society. After my three-year term as Secretary I was asked to run for Vice President/President Elect and I got elected. So my tenure on the ORSA Council was long. At that time, the Past President served three more years. So you were Vice President/President Elect, President, and Past President, that was five years. Then three years as Secretary and three years as council member, 11 years in all.

BOB SHELDON: Did you see some of the same people attending ORSA and MORS?

JACK BORSTING: Oh yes. At the same time, I was involved in the Military Applications Section at ORSA. I guess the reason I got involved with ORSA more than TIMS was because ORSA had more of the military OR people involved. When ORSA and TIMS were formed in the early days—I was told, I was not there—but the military people went more toward ORSA and the non-military or business types went more toward TIMS. Not completely, but most people were members of both. I was a member of both, but I was much more active in ORSA. Then when I became Vice President/President Elect, we started a liaison between the two and we got joint meetings and formed a memorandum of understanding between ORSA and TIMS, which led to the eventual merger. Bob Oliver was President of ORSA at the time I was President Elect. It did not make

much sense to have two societies. I always thought they should be merged. Then in my year of presidency, the main thing I did was try to consolidate the alliance that was made the year before. So we consolidated—joint publications, joint meetings, but still had two separate societies.

BOB SHELDON: What year did they consolidate?

JACK BORSTING: I was President of ORSA in 1975–76, so the consolidation was in 1974–75. That was not a merger, but I call it an alliance.

BOB SHELDON: Any other notable players that you worked with in the ORSA meetings that we would not know about in MORS?

JACK BORSTING: Well, there were a lot of military people who had some activity in MORS too. One was Joe Engel who was at CNA for years and he was a military analyst. Of course Morse and Kimball, some pioneers of the field were active in ORSA. They also did military OR work.

BOB SHELDON: For your people you were paying to go to professional society meetings like MORS and ORSA, how did you justify the value of those meetings? Were the meetings justified based on exposure and bringing back new information?

JACK BORSTING: They presented papers, and all of the above reasons apply. First, it was an outlet for classified communications and second, it had fine working groups. The working groups were very valuable to have people in the same area working together over a period of time. I always thought the working groups were much more valuable than the other sessions.

BOB SHELDON: Which working groups did you go to in the early days of MORS?

JACK BORSTING: I can't remember which ones I went to quite candidly, but I always went to several groups. They had education working groups too, so I went to those because there were a lot of them in the early days. I was trying to determine what a Military Operations Research master's degree program should look like?

BOB SHELDON: We still have those discussions in MORS.

JACK BORSTING: Well, it's not settled yet. In the early days the Postgraduate School program was an interdisciplinary program that was mostly mathematics, computers and physics. When I came here, they had seven physics courses in the curriculum. The present curriculum doesn't have any physics courses, which I think is very unfortunate and a mistake. But there will always be an argument on how much theory and how much application. I still remember a discussion at a meeting, I don't know whether it was a MORS or ORSA session on education, where Russ Ackoff from Case and Ron Shepard from Berkeley were arguing. Ackoff wanted all applications, Shepard wanted all theory, and I thought they were both wrong, and I told them so at the meeting. I said they were not communicating because they were 180 degrees apart. The student should have a good sound grounding in basic math, science and engineering, and then you should try to teach the art of model building and bridge the gap between theory and applications. There were very theoretical programs, like Berkeley's and Cornell's. In the early days, Johns Hopkins had a pretty good mix of both theory and application. What I tried to do during my chairmanship of the department, and I was chairman nine years, was to bridge the gap—have some theory and then have applications at the end of the program so that the student would have some feeling of what model building and applied OR is all about. I emphasized this because model building is really an art. Applied mathematics alone won't do. But if you just have the basic tools you can't do it either. So that was the philosophy of Monterey's OR Department. When I was Chairman, we still had some physics courses in the program, but less physics courses than when we started, because I thought we had too many physics courses. We had to make room for other subjects, more computer science, for example. We also had to make room for some economics and human engineering, human factors. We added human engineering and human factors into our OR program.

In fact, in the early days of the program, there were some people who thought there should be a separate systems analysis program and a separate operations research program.

Systems analysis and economic modeling was being done by CNA. The OR techniques like search theory, which the old OEG group of CNA would do, was being called operations research. Some individuals thought there should be one program in systems analysis and one program in operations research. I thought that was crazy. We named the department the Operations Analysis Department and called the curriculum the Operations Research/Systems Analysis Curriculum. We had all bases covered. I also hired economists to do the systems analysis part. There was a conflict with some of the economists who were hired in the management group, who thought they should have a special systems analysis program, but that was never done, fortunately. The conflict was completely resolved in 1971. The OR Department had grown from three people when I took it to over 50. We had a large student body at that time of OR students from all services and international students. The then Provost, Milt Clauser called me into his office and said, "Jack, the Management group needs to be strengthened. It is not as strong as it should be. Since you built the OR group into one of the best departments in the country will you take over the management group and build it?" So I said, "Milt, I'm going to think about it and get back to you." So I came back to him and said, "No. I would not do that, but if you want to merge the two, I would use the OR excellence to build the Management faculty." He said, "Fine." The two departments were merged and I ended up with a department of 85 people. This was in 1971. At that time the department had 40% of the Postgraduate School student body. We did increase the quality of the Management group and then in 1974, the Superintendent called me and said, "We would like you to be the new Provost." Milt Clauser had retired and was ill unfortunately, with a disease that was fatal. I said, "Sure, I'll be the Provost." In about 1976 or 77, I split the departments. Some of the faculty who had been in one of the departments chose to switch into the other department.

BOB SHELDON: Who was the head of the OR department when you split them?

JACK BORSTING: The OR head was Dave Schrady.

BOB SHELDON: For management, was this an MBA style of management?

JACK BORSTING: No, it was a Master's of Science in Management. It was oriented towards the Department of Defense. The curriculum was a cross between a Master's of Public Administration and an MBA, but with an orientation to defense. So it was called a Master's of Science in Management.

BOB SHELDON: Did they require a fair amount of quantitative analysis?

JACK BORSTING: Yes. It was of course more of a management program. It had some system analysis/operations research, accounting, organizational behavior and some applied statistics, but not to the depth that was in the operations research program. The OR program at that time was a two-year program and it had a thesis attached to it. Management was an 18-month program at that time. They have all been shortened now. In fact, the operations research program had a very important component. It had a six-week summer experience tour. The student would go to a working OR organization, like CNA, or some organization in the Army, or in industry where they would work on an OR problem. Many times that would be their thesis problem. They would come back to NPS and find a faculty advisor. The students would also work with the applied person whom they worked with during their internship. About half the summer experience tours resulted in theses. I felt that was a very important part of the program, because most of the students were not going on to obtain a Ph.D. This was a terminal degree for them. The program had a thesis requirement, which still exists today. There is always the effort to cut it out, but I think it is very, very important.

BOB SHELDON: Let me backtrack. When you were active teaching, before you became a department head, do you recall any of the thesis topics you supervised?

JACK BORSTING: I supervised many theses. Most of these were probability modeling of a military problem. I also supervised some classification/discriminant analysis theses, because that was one of my research areas. In the early days, about 1961, I had one student write a random number generator for the CDC 1604 because there was none available.

BOB SHELDON: What were your responsibilities as a new Provost when you took on that role?

JACK BORSTING: My main responsibility as Provost was to get the school out of a deep hole. The school student body around 1971 was about 1800. There had been cuts in graduate education by various organizations in Washington, including the Congress. When I took over, the student body was 1200 and going down. It went down to 900 in the next two years. When I left the provost position in 1980 and went to Washington, the student population was back to 1400. My job was to convince OSD, the Navy, the Army, the Air Force, and the Congress what a great institution NPS was and how important graduate education was to the future defense of the country. During this time of a severely declining budget it was very important to preserve the quality of the faculty. During this period we did not fire any tenured faculty. What we did was significantly increase the amount of sponsored research. We did not cut any faculty that we really wanted to keep. We also increased the tenure and reappointment standards, which was good for the school. Many faculty at that time were half-time research and half-time teaching on a 12-month basis. Some of them, on an academic year basis, were half-time teaching, half-time research.

It was trying times, because we had everybody in Washington, D.C. looking at us. In fact, I was pleased that I reversed one cut from the Senate Appropriations Committee. A former faculty member here was working as a staffer for the Senate Appropriations Committee; he was working for Senator Brook of Massachusetts. We got Senator Brook to reverse a 10% cut in the total number of graduate students across all services. The cut was decreased to a 5% cut and Brook weighed in because we gave him a convincing argument on military human capital. It was a good argument. A lot of my time was spent lobbying in Washington and keeping the faculty happy and productive. I tried not to let the faculty worry about the cuts. We kept a lot of the details from the faculty because the faculty's job was to do their teaching and publish. If they started worrying too much, they wouldn't be productive. At the time I was told by my Deans that I should have told the faculty more of the problems, because the school was in danger of being closed. During this period Bill Clements, the Deputy Secretary of Defense, appointed a blue ribbon committee of the service Secretaries to evaluate Defense educational programs. They looked at all the service institutions, war colleges, command and staff schools, and graduate schools. He was convinced until he came out with this group that the school should close. Once he came out and saw what was happening, he was a strong supporter. The committee had a great staff. They had two Rhodes scholars. The Air Force officer Dave Rowe was a Rhodes' scholar, Pete Dawkins was the Army staffer and also a Rhodes' scholar. The Navy's representative was an OR graduate from Monterey. The staffers for this study looked at all the service institutions before the committee made their visit. We also had a Blue Ribbon Committee at that time chaired by the Provost of Berkeley. Other members of the committee were John Slaughter, the former director of NSF (National Science Foundation) and Chancellor of the University of Maryland; Don Rice, the President of RAND; Bill Perry and several engineering Deans. They wrote a great report, which documented the uniqueness and quality of the school. The report was used by the School for many years. Most people who find out about this institution are great supporters.

I attended some MORS Symposia and some ORSA meetings when I was Provost. I didn't attend them all because I was pretty busy. Then in 1976, when the Carter Administration came in, Graham Claytor was the Secretary of the Navy and Jim Woolsey was the Under Secretary. I was offered the Assistant Secretary of the Navy for Financial Management. I said, "No." My son was a senior in high school and I wasn't going to move. Then a couple of years later, Bill Perry who was the Under Secretary for Acquisition called and wanted me to be the Deputy Under Secretary for 6.1 and 6.2. I called him back a couple of days later and said, "Bill I'm not enough of an engineer/scientist to do that job well." I thought I could do the job, but I didn't think it was right for me. Later Graham Claytor became the Deputy Secretary of Defense, and I got a call from him to interview for the Assistant Secretary Comptroller i.e., the

Chief Financial Officer of the Department. Harold Brown offered me the job and I accepted. In 1980, I went back to be the Assistant Secretary (Comptroller) of the Defense Department. When the Reagan Administration came on I was reappointed by the Reagan Administration, so I was able to stay in the Comptroller's job for a while. In 1981, MORS awarded me the Wanner Award and had me be the plenary speaker at the 47th MORS Symposium in Washington, D.C. The title of my talk was "Defense Decision Making". The talk was later published in the TIMS Journal. That was my last MORS Symposium for a while. When I left the Pentagon in 1983, I went to be Dean of the Business School at the University of Miami. I left Miami in 1988 to become Dean of the Business School at the University of Southern California.

When Robert McNamara was Secretary of Defense, he had Charles Hitch as his Assistant Secretary Comptroller. In the early 60s, the Program and Analysis group and the Comptroller were in one office. Charlie Hitch had responsibility for both sides. Sometime later the organization was broken up and the Program and Analysis group was separated from the Comptroller. When I became the Comptroller in 1980, that was the case. I worked very close with the Program and Analysis people. The Comptroller shop, when I took over, was just involved with the budget part, and I thought that this was wrong. I wanted to be involved with the planning, the programming and the budget. Therefore, I created a small new group and asked Mike Sovereign who was NPS OR professor to head the group. Mike's group was doing what I would call liaison between the planning phase and the programming phase. One of the people that was hired for this shop was Steve Balut who was a Naval officer at the time and who was the first Ph.D. in Operations Research granted by the Naval Postgraduate School. The group helped me to bridge the gap between the planning, the programming, and the budget phases. What I was hoping for was that my budget staff would get more involved in the entire PPBS process.

When Secretary Weinberger testified in Congress I was always with him. He had the Chairman of the Joint Chiefs, who at that time was David Jones, on one side and me on the other. He was asked questions about the planning phase, the programming phase, etc., not just the budget phase. I had to know about the entire process. Initially, my staff would give me just a briefing book on the budget numbers. The new group was very important for me when I testified as the Comptroller and when I assisted the Secretary.

BOB SHELDON: Did your Operations Research background help you in doing that?

JACK BORSTING: Oh yes. The Operations Research background really helped and so did my math education, because I was able to do back of the envelope analysis very quickly. My staff would bring me papers. I would look at the paper and I would look at the answer, and sometimes I would say, "This is wrong." "Well, how can you tell it's wrong?" I said, "I know it's wrong." I just did a rough calculation. Now, I did not do any linear programming or queueing theory or any sophisticated analysis, but I did do a lot of what you might call back of the envelope analysis. Of course, I had my special projects staff with Mike and Steve and they did some analysis when it was appropriate. I used the analysis that first Russ Murray's shop did under the Harold Brown administration, and then with David Chu under Secretary Weinberger. I used a lot of their analysis because I didn't want to duplicate it. There is now an Under Secretary and PA&E is back in the Comptroller shop. The analysis in the Comptroller shop that I personally did was very basic. When I left the Pentagon and went to Miami, I was fortunate in being able to keep active in the defense analysis because I was asked to be a Trustee of the Center for Naval Analyses, CNA. I was on the CNA Board for 12 years; and I also was on the Aerospace Corporation Board, which is a systems engineering organization that does work in the AF space program. I was on the Aerospace Board until I went on the Northrop Grumman Board in 1991. I was asked to be on the IDA Board and I became an IDA trustee and just went off the board last March. I concurrently served on the CNA Board, the IDA Board and the Aerospace Board. I was really keeping my hands involved in defense even though I was a professor in a business school. Steve Balut at IDA has, in my view, built the

premier cost analyses group in this country. He has had an informal review group that was composed of me, Mike Sovereign, and one other trustee. We would meet a couple of times a year and review the Division's programs.

When Jack Vessey was the Chairman of the Joint Chiefs, he wanted a JCS force planning model developed. IDA was chosen as the contractor. The program developed included a cost model, an effectiveness model, and an integration model. The program had an outside independent review panel. The members were General Donald Bennett, USA, retired; General Russell Dougherty USAF, retired; Admiral Harry Train, USN, retired; and me. I was on the Board of Northrop Grumman for ten years. We, of course, were doing analysis, but at a high level. It was very interesting to watch Northrop Grumman go from a six billion dollar corporation to a 29 billion dollar corporation over time.

BOB SHELDON: What did you contribute to those boards? What kind of advice do you give?

JACK BORSTING: I've served on about eight public company boards, several nonprofit and also some private company boards. Many of the boards have had me chair the audit committee. I'm not sure that's been my major contribution, as I have been on other committees. At Northrop Grumman, I was on the nominating and corporate governance committee, the audit committee and the compensation committee. I chaired the nominating committee for seven years. I believe my main contribution on all the boards I have been on was to be able to look at the strategic direction of the company and when the company had problems, to cut through all the chaff and get to the heart of the issue. My mathematics and analysis training enable me to get rid of the extraneous information and formulate the issues in simple terms.

BOB SHELDON: Can you give an example of the specific problems you found or helped with?

JACK BORSTING: At Northrop Grumman I worked with the CEO and a former Monterey OR graduate, Jim Roche, to change the strategic direction of the company and emphasize systems integration and electronic warfare more than airplane building. That is one example.

MIKE GARRAMBONE: How did you go about looking at those? Was it like seeing problems through analysis or were they more of a discussion of where you think you want to go?

JACK BORSTING: Well, both. The corporation would do some work and present the alternatives to the board and then the board would ask questions. There are always a lot of extraneous issues around, which is normal in a meeting of this kind. The important thing is to get rid of these issues and say, "This is what we should really focus on. This is the key issue." I am a believer that for boards of companies their primary job is two-fold. One, is to hire and fire the CEO and two, is to help the CEO and senior staff set a strategic direction for the company. I have been involved in firing CEOs, but we won't go into details here.

BOB SHELDON: Later you went on to head other university business schools. How would you view those schools as compared to your experience at the Naval Postgraduate School?

JACK BORSTING: The faculty at NPS was easier to work with than the faculties at the other schools. The other schools weren't hard to work with, but the faculty at NPS was more focused on the mission of the institution and as a result was a little easier to work with.

BOB SHELDON: Were those departments already established when you got there?

JACK BORSTING: I was hired by the University of Miami to build the Business School. We had to increase the quality of the faculty and the students. Also, we had to raise money. One of the jobs of the Dean of any private business school or any business school is to raise money from alumni, business leaders, and foundations. In Miami, I spent about half my time raising money. They had no endowed chairs. When I left there were six endowed chairs. We did not have a business affiliate program, which is a program to bridge the gap between the business school and industry. When I left, we had 110 corporate affiliates who paid certain amounts of money to the school each year. At USC, which had a more established business school with a better reputation, it turned out my main mission was to sort out the financial mess I inherited. I won't go into detail, but the school was spending money it

did not have. For a business school, it did not have a good financial system. None of the departments had budgets. The entire decision making was done at the Dean level. Obviously, this does not work when you have over 4,000 students and about 190 faculty. To have all the small decisions made at the Dean's office made no sense at all. As a result, the school was spending too much money. I had to straighten things out financially, and then we continued to build the quality of the faculty and students and raise more money. We were really able to increase the quality of the students at USC. The full-time MBA student average GMAT score was around 580 when I got there. After six years when I left the Deanship it was around 630 and my successor continued to increase the scores to over 700.

MIKE GARRAMBONE: So you found a better process of bringing good students in?

JACK BORSTING: Yes.

MIKE GARRAMBONE: Was it easier to teach those higher quality students?

JACK BORSTING: Oh yes. The undergraduates at USC were not of as high quality as the graduate students. The present President significantly increased the quality of the undergraduate student body. The average SAT's at University of Southern California were about 1085 when he arrived. Now they are about 1340 and of the other research universities in the western United States, there are only two that are higher, Stanford and Cal Tech. It is much nicer to teach brighter students.

BOB SHELDON: You still have, via your former students and people you worked with under Weinberger's group, some close contacts with current officials in the Department of Defense. How do you feel about the current trends in the Department of Defense regarding using analysis to make good sound decisions?

JACK BORSTING: The status of analysis has changed over the years, depending on the Secretary of Defense and how the Secretary wanted to use the analysis. It is my impression that Mr. Rumsfeld is really using analysis to help him make decisions. The services have also gone through cycles. I think the Navy, as Admiral Tracey said in the Plenary Session, is building up their in-house analysis group. Certainly it has changed from the days of McNamara when analysis was used a lot. Then, with various other Secretaries it wasn't used as much, and I believe now it is being used more.

BOB SHELDON: What do you see as indications of that?

JACK BORSTING: Knowing Rumsfeld's background and talking to people. Also, being on the Board of IDA I saw that the number of studies that were funded increased.

MIKE GARRAMBONE: I'm sure in your analyses, you ended up doing a little teaching or perhaps providing little bit of education to the decision maker to help them better understand your studies.

JACK BORSTING: Well, it depends on the individual and their background. You know, Rumsfeld was a trustee of the RAND Corporation for years. So he was involved in an overview of the RAND Corporation's analyses. I'm sure, his background influenced his feeling of analysis and also at the time he was a former Secretary of Defense. Harold Brown was a quantitative type who definitely appreciated analysis. So I think most of the Secretaries have an appreciation of analysis already. There is probably more constant use of analysis at the OSD level than the service level. That is my estimate from afar at this point in time.

BOB SHELDON: When you return to the Naval Postgraduate School, how do you see the Postgraduate School OR Department changing since you left years ago?

JACK BORSTING: That's an interesting question. I think there should be a physics course or two in the present curriculum, particularly for naval officers who are going to do ASW analysis. The program when you compare it to programs at civilian universities stacks up very well. It has a good mix of theory and applications, but I would like to see a bit more applications. Most Operations Research programs in civilian universities, in my view, lean too much towards applied mathematics.

MIKE GARRAMBONE: You mentioned physics particularly for submariners.

JACK BORSTING: Not just for the submariners, but even for air and surface officers. If you are modeling a physical environment you should have a little feel for the physics of the situation. The course should not be a standard physics course, but should emphasize model

building. In my view physics is just model building. That is not usually how physics professors teach their courses.

MIKE GARRAMBONE: How do you help professors become better? Taking on challenges in the classroom or introducing topic discussions? I'm sure you had an influence on how things turned out in the classroom or fostered research directions.

JACK BORSTING: Well, it's very difficult to lead professors. One of my colleagues, Warren Bennis, has said in his books, "Leading professors is like trying to herd cats". One of the things I did do as Chairman of the OR Department and as Provost, was to encourage faculty to spend time at laboratories or in the Pentagon. I thought that would be very good for their career. Dick Elster, for example, had two tours in Washington—one in the Navy and one in OSD. Other faculty have gone to Washington and various government labs. Some have stayed, which is unfortunate for the Postgraduate School, but is still good for the Defense Department. It was easier to do it here than it was at the University of Southern California and the University of Miami, but I think it would be good for the faculty to work in industry for a while, particularly in a professional school, like a business school. I think that engineering schools and business schools have become too theoretical in their programs. The theory is very important, but you have to have a mix. You have to be able to somehow bridge the gap between theory and applications. This is particularly true at the master's level where you are giving a professional terminal degree. At most civilian universities, they are really interested in the Ph.D. The master's degree many times is the consolation prize if the person is going towards a doctorate.

BOB SHELDON: Do you have any hobbies outside of doing your University work and your mathematics?

JACK BORSTING: Well, I should mention that I have gotten much more interested in pro bono activities. I am on the Orthopedic Hospital Board of Los Angeles, which is a private, hospital specializing in orthopedics. I chaired the foundation board for two years and then chaired the board of the hospital for three years. I am still working for Orthopedic Hospital. The hospital provides free care for many children who do not have insurance. I am currently on the Army Science Board. I am also on the Board of the Rose Hills Foundation, which has a 380 million dollar endowment that supports gifts to charities in the Southern California area, particularly the greater San Gabriel Valley. It is very satisfying to help the less fortunate. As far as other hobbies, I play a little golf, although my back limits the amount. I play some tennis and I like to read.

BOB SHELDON: Your selected reading material, is it technical or non-technical?

JACK BORSTING: Non-technical—mostly mystery novels.

MIKE GARRAMBONE: Please mention a few of your mentors?

JACK BORSTING: I've been asked that question before and it's a hard question for me to answer. Over the years I picked up different things from people I worked with, but I would not say that I have had any mentors. For example, one of the Superintendents at the Postgraduate School, Bob McNitt, would write handwritten notes to people on special occasions. I have done the same thing ever since. His secretary classified him as having a velvet hammer. (*Laughs*) I have tried to be smooth in dealing with people, but also firm. I try to listen to them and deal with them in a fair way. There are lots of people I have learned from. My statistics professors, who showed me how they approach problems, mentored me in that way.

MIKE GARRAMBONE: I've always been influenced by some teacher in the classroom, someone who was generally enthusiastic about a topic. Could be a math professor? Do you have a few of those?

JACK BORSTING: Well, certainly, in graduate school. I had one of the most disorganized teachers you could find, but he was very good and was the chairman of the department. I learned a lot from him. He really made me think. Then I had another professor who was the best expositor I have ever had. He taught me number theory and advanced algebra. He was the smoothest teacher I have ever seen, and yet I am not sure I learned as much from him as I did from the other individual, who taught me advanced calculus and complex variability the-

ory. I learned from both of them, but they were very different.

The following transcript is from the MORS Heritage Session at the 72nd MORS Symposium at the Naval Postgraduate School, Monterey, California, 23 June 2004.

INTRODUCTION: Each year as part of the MORS annual symposium distinguished speakers are invited to provide their thoughts and comments on the development of Operation Research during their early years as analysts, educators, study directors, or analytical agency leaders. The presentations they make and the discussions that follow are based on their unique experiences in OR and the wealth of knowledge about our historical past. This year at our MORS Symposium, Mr. Eugene Visco, as Chairman of the 72nd Heritage Session and Mr. Lee Dick, the Chairman of the Heritage Committee have brought together two of our finest and most senior colleagues to discuss early OR and the significant events and interesting occurrences that took place "on their watch." Today we are pleased to have Dean Wayne P. Hughes, Jr., of the Naval Postgraduate School (NPS) and Dr. Jack R. Borsting, former Dean of Academics and Provost of NPS to address this session.

LEE DICK: First I'd like to thank Gene Visco here for lining up our Heritage speakers for today. We had three icons in our profession who were lined up; unfortunately one of those, Phil Depoy, could not be with us. He is taking care of his wife who has lung cancer. But we do have two with us today. And they have a lot of commonality between them. They are both MORS Past Presidents, both MORS Fellows, both distinguished faculty and both deans of the Naval Postgraduate School. I'll start off with Dr. Borsting here. He was the former Dean of Academics and Provost; in fact, I believe he was Provost when I was a student here. He left then to become OSD Comptroller for Presidents Carter and Reagan. He's now Professor Emeritus at the Marshall School at the University of Southern California. So, Dr. Borsting.

JACK BORSTING: I don't think Wayne and I have prepared remarks. We'd like to talk a bit and get the audience talking with us, which would be much better than giving a dry lecture. Anybody with spitballs stay in the back. {Laughter} I'll correct one thing in the introduction. You said Professor Emeritus at USC; it's Dean Emeritus. I'm still a professor at the University of Southern California, so I'm not quite put out to pasture yet. Soon maybe, but not yet.

It's too bad Phil wasn't here for this heritage session because I believe Phil goes back in OR history further than either of us. But we'll try to pick it up, right Wayne?

WAYNE HUGHES: Phil is a dear friend with wonderful recollections.

JACK BORSTING: I told Gene Visco I would not have any prepared remarks and would like to take questions from the audience and he said, "Well, just talk about the early days of OR and when you were Comptroller and what analysis took place during this period." So that's what I will do.

I got into the field of Operations Research in a very unusual way. I came to the Postgraduate School in 1959, as assistant professor of mathematics and was mainly interested in teaching probability and statistics. The OR program was one of the reasons I came here, but there was no OR department at the time. A few years later one of the professors in the mathematics department who was active in OR, in fact the program was being run by two professors of mathematics and one professor of physics, talked the hierarchy of the Postgraduate School into creating an OR department. The only individual who transferred into the OR department at the time was Tom Oberbeck who became the Chair. Tom recruited a couple of their people, but I stayed in the math department. In 1964, Tom got into a fight with the administration and quit. The Superintendent, the President of the Postgraduate School, called me into his office and said, "I'd like you to become the chairman of the OR department." I thought the OR program was great, but I was still an associate professor and pretty young at the time. So I said, "Well how long do I have to make up my mind." He said, "24 hours". So I spent a lot of time talking to people and came in and said, "Yes, I'd do it". And that started my OR career. I had to learn more about OR in a short period of time, so I started going to MORS meetings and also to ORSA meetings. In fact,

the first summer I was chairman, the Polaris Program was running a summer study program at NPS. Any of you remember John Craven? It's probably too far back. John was in charge of the study, and so I became a member of the study team. I got involved with MORS, and this was a very good thing—because I became a Director of MORS and then a Vice President in 1971. In 1972, I became the President of MORS, and I was also active in ORSA and became the President of ORSA in 1975–1976. I learned a lot about Operations Research by participating in various working groups at MORS.

I really wasn't involved in the early days of OR (Just after World War II). Maybe one of my former students was, Wayne Hughes, he's a bit older you see. Were you involved in World War II, Wayne?

It's too bad we're talking about heritage days and we don't have some people that were involved in the forties and fifties. Some of the people are still alive, like Joe Engel and others who were involved in starting ORSA and TIMS in the early 1950's. I came into the field in 1964. One of my early students in the probability and statistics courses I taught was Wayne Hughes. What year did you start the OR program at NPS?

WAYNE HUGHES: Nineteen sixty-two.

JACK BORSTING: Wayne came as a student in 1962 and I had him for several classes because there weren't very many OR professors at the time. It was a difficult environment to recruit OR professors. The OR program at Monterey, which started way back in about 1951, was basically physics, mathematics and computer science. In fact, when I came it had seven physics courses. I don't think it has any physics courses in the program now? (True: Wayne). I think it should have some physics courses—Wave Theory, et cetera, so that analysts can appreciate the physical phenomenon they are modeling.

Of the professors we recruited, most had degrees in other fields besides Operations Research because many of the Operations Research programs were just starting. Case Western Reserve University (formerly Case Institute of Technology) started an early OR Ph.D. program and one of the early recruits in the department was Dave Schrady. Dave had his Doctorate from Case Western in Operations Research. But some of the other early recruits, Bob Read, who is here earned his degree in Probability and Statistics from UC Berkeley. And Mike Sovereign who is also in the audience has a Ph.D. in Economics from the University of Illinois. Mike and Bob were early recruits who worked to develop the OR program. The OR program evolved into a mix of theory and applications. Are there any other OR professors here?

RUSS RICHARDS: I came in 1970.

JACK BORSTING: In 1964, when I was lucky enough to become Chairman, the department had three faculty members including myself. A year later, the Probability and Statistics faculty moved over from the math department. The Provost in 1970 decided that he wanted to do something with the management group. We were 50 faculty in the OR department and the Provost merged the two departments. The Department of Operations Research and Administrative Sciences had 85 faculty members. So I had 85 faculty members as a department chair. In 1974, I was fortunate to be selected as the Provost. When I became Provost, I wasn't doing very much OR.

Gene wanted me to talk about when I was in the Pentagon and what OR was like there. I was in the Pentagon from 1980 through 1982. At the time the PA&E and Comptroller shops were separate as I believe all of you might remember. They started out under one boss when Charlie Hitch was the Assistant Secretary (Comptroller) with PA&E and the Budget shop under him. I think that is the way it should be, and I believe it's that way now. Well, when I came as Comptroller most of my, in fact all of my people were budget people. We were just looking at the end game, i.e. the budget part of the PPBS system. We didn't get involved in the planning or the programming phase. There was not any analysis done in the Comptroller's shop, so when I came into the position I decided it would be a good idea to do some analysis. I was appointed the Comptroller when Harold Brown was the Secretary of Defense. Harold testified by himself. I would give him a report and the next day it was back on my desk with handwritten comments. He had

read the whole report. He just wouldn't read the Executive Summary I wrote. Secretary Weinberger operated much differently. I was in his office every morning at nine o'clock for a staff meeting and whenever he testified, no matter where he testified, he had the Chairman of the Joint Chiefs on his left and me on the right. He was asked not just budget questions but analysis questions, programming questions, and planning questions. Initially, my staff would just give me the budget numbers. I created a special project group to do my own analysis. I was fortunate in getting Mike Sovereign to come to Washington, DC and head that group. You (Mike) should really be up here talking. Mike Sovereign was in this group along with Joe Kammerer and Steve Balut. Steve Balut, who is sitting in the back of the room, was the OR department's first Ph.D. The group performed some analysis that helped me and made the budget types a little broader. Mike, you observed the system. Did I make the budget staff look a little more across the spectrum in the PPBS system?

MIKE SOVEREIGN: Oh yes. I think they did.

JACK BORSTING: The staff in the Comptroller's organization always made changes in the "end game" just before the budget was submitted to Congress. If the staff didn't think something was a good thing to do, they would try to cut it out at the last minute in the budget process. We were able to do a bit more analysis and contribute to the planning and budget phases. By the way, I should mention one thing; I played the "end game" once as Comptroller. The nuclear submariners in the Navy wanted to cut out all of the diesel submarines. Any submariners here? No? Okay. Well, we had done enough analysis at Postgraduate School to show that diesel submarines had some benefit to the Navy. One reason, in certain barrier operations they were very quiet and hard to detect. They were quieter than nuclear powered ships when on battery. Also many of the countries around the globe had diesel submarines. And so the Navy, in our view, my view in particular, should have some diesels in the fleet. When I was Comptroller we'd saved the diesel submarines from being decommissioned. I went to Claytor, the Deputy Secretary and he said, "I agree with you, Jack", and so they continued to be in the fleet. After I left, the last diesel submarine was removed from the force. I believe this was good use of the analysis performed at the Postgraduate School. It was playing the budget "end game," but I believe it was positive for our force structure.

So we really didn't do, in the Comptroller shop, a great amount of analysis. Mike's shop did some. We also tried to get mission budgeting in, didn't we Mike? We let some steady contracts that would assist us in moving toward mission budgeting.

MIKE SOVEREIGN: Relating R&D back to the mission.

JACK BORSTING: Yes, relating R&D back in the mission, and we tried to do some things to streamline the process and make it more relevant.

UNKNOWN: In that example for the submarines, were there analysis shops that were saying this versus that? That you were doing and comparing results to, or were they separate camps? Or did analysis happen at all in the submarine crowd?

JACK BORSTING: I do not remember all the details. But I believe the submariners did their own analysis. In 1980, 1981, and 1982, the submariners had a lot of control over the entire Navy.

UNKNOWN: Yes, Admiral Rickover was still in power then.

JACK BORSTING: Admiral Rickover, yes. The kindly gentleman was still wielding his power. So I'm not sure how much analysis was done except that nuclear submarines were obviously better than diesels. And, of course, in most respects they are.

UNKNOWN: I was on a field assignment at the time. In exercises; they used to force the diesels to snorkel. Otherwise, they just would shoot the submarine; the Navy didn't want to hear that.

JACK BORSTING: You couldn't hear them and so that was one thing. Any other questions about analysis on the Comptroller's side?

UNKNOWN: Yes. Were you involved at all in the analysis or anything in bringing back the battleships?

JACK BORSTING: Yes. We brought back the battleships, but I wasn't personally involved in the decision. I should mention it was quite a shift between the days of Harold Brown and the days of Cap Weinberger. When I was interviewed for the Comptroller job by Harold Brown I said, "It seems to me that you're centralizing power in the Secretary's office. The Secretary is making a lot of decisions on what systems are going to be funded versus what happened under the Laird/Packard era. I think you're going back to the McNamara days". He smiled at me and said, "You're right, Jack". I said, "Do you think that's really a good idea?" So we argued for a while. As I walked out of the room I said to myself, "There goes that job". But two days later I got a call, "The White House wants to talk to you". It was the White House patching Brown in, he went through the White House switch. He got me at home and offered me the job and I said, "Yes". I guess my questioning the Secretary was a good strategy.

Speaking of other analysis, maybe some of you could help on this. This was also the time that the B-1B came into play. My staff analysis was that it was not cost effective to modify the B-1. The politics of the time was that the Reagan administration wanted a major weapons system in the eight years they were in power and they chose the B-1B. So the decision was made to go ahead with the modified B-1 even though the B-2 was on the drawing board and being built. In fact, it was very interesting because I had to go and testify before Congress about the costs of the B-1B before the Armed Services Committee, and Senator Levin was not a friendly questioner. Just before I was supposed to go over to the hill I went into Secretary Carlucci's office with Dave Chu and I said, "What are the costs? I have to testify in one hour". And they said, "We don't know, just dance". This is what Carlucci told me. I went to the hill with my dancing shoes and confused Senator Levin. I gave him cost numbers in '80, '81, '82 constant dollars and played the confusion game. He got very confused, but I couldn't do anything else because we didn't know the official cost numbers.

UNKNOWN: I was very interested that you worked the transition not just between administrations but from a Democrat to a Republican who more or less ran against that administration. How were you able to gain the confidence of the decision makers you were supporting with analysis after the transition?

JACK BORSTING: First, I was the Comptroller, more of a professional position. Second, I came in late in the administration. Third, I was a Republican from California. I was the only cabinet or sub-cabinet appointee that got reappointed in the same position. The Reagan people wanted everybody out that had been appointed by Carter as a presidential appointment. It turned out that Cap Weinberger and Frank Carlucci asked about my work, and decided they wanted to keep me. What I didn't know for sure was if I could stay. They wouldn't accept my resignation, they out waited the White House and I was reappointed in October 1981. I believe they wanted somebody with some continuity and they heard I was unbiased.

There's an interesting story after Harold Brown offered me the job. A week later a White House person in the Defense Department called me up and said, "You know we need some paperwork to get you through the White House and then confirmed by the Congress". And he said, "By the way we didn't ask you what your party was". I said, "Well, I'm a registered Republican". He said, "Oh ****". After a pause he said, "Harold Brown doesn't care but if the White House cares would you change your party?" I said, "That's the White House's problem, not my problem". So that gives you a little background. I believe you shouldn't really have a political person as Comptroller because I dealt with OMB and various congressional committees on the budget. I testified before appropriations committees, both House and Senate both Armed Services Committees and the Congressional Budget Committee. I tried to be the honest broker in my testimony. Of course, I couldn't testify against the administration's position and go around the administration's positions. Some political appointees do, and I believed this is not professional. I didn't think we should have a B-1B bomber, but I wasn't going to argue against it in public. Therefore I argued for it, if I felt that I couldn't do that, I should quit the job. Pure and simple.

UNKNOWN: When you were testifying in front of Congress, did they brief you in advance as to what they were going to ask you or did they ever blindside you with questions?

JACK BORSTING: Your staff tried to brief you but you were nearly always blindsided. In fact, in my confirmation hearing, they briefed me on questions that Senator Levin and other members might ask me. There were only three Senators in attendance at the Armed Service Committee when I was confirmed. Senator Exxon from Nebraska chaired it; Senator Levin and Senator Warner were there. Senator Exxon turned to Levin and Levin's first question was, "Do you have a brother named Billy?" (Laughter) Now how do you answer that? You know with Billy Carter in the news. Should I be flippant? I decided I'd better not be flippant. So I said, "Senator I have no brothers or sisters". And Exxon turned to Levin and said, "You're out of order". The question and answer did not appear in the Congressional record. Senator Levin proceeded to ask me questions that my staff didn't brief me on. They were obscure detailed financial questions that I couldn't answer. I said I would answer them for the record, which I did. Your staff could never prepare you for all the questions.

The first time I testified with Secretary Weinberger was on the '82 budget and the '81 supplement. Joe Addabo was quite a character; he was the chairman of the committee. Jamie Witten was the chairman of the overall appropriations committee. Jamie came in the room and Addabo stopped and said, "I know you're busy Chairman Witten, but would you like to ask Secretary Weinberger some questions?" "Yes" he said. And then he said, "Mr. Secretary, I've been listening to you now for the last ten minutes and you know you're just like Mr. McNamara, you haven't said a damn thing". Now, he really hit Weinberger because Weinberger didn't think that much of McNamara, and he also said he didn't say a damn thing. This was his first time on the hill. Then Witten proceeded to ask a question and I wasn't sure what the question was. Weinberger turned to me for the answer and I gave him a piece of paper. I said, "1981 supplemental or 1982?" He really didn't know either, so he wrote me back a little note saying '47. That was when Witten was elected to the Congress for the first time.

Some of you may have known Derrick Vandershaft who became the Defense Department IG. He was a senior staffer on House Appropriations and would write the questions and then sit behind the members and point his finger to help the Congressman read the questions. So it was an interesting time testifying. We did not worry about not knowing the answers to all the questions. You worked with your staff to prepare. But the Congressmen or Senators always asked you questions you weren't prepared for. Fortunately, the answer could be provided for the record.

UNKNOWN: Totally different question and maybe give us a chance to move into another arena. What kind of a student was he [Wayne Hughes]?

WAYNE HUGHES: Wait a minute, I've got a rebuttal.

JACK BORSTING: I was just going to introduce Wayne before we got off on these other questions because in the early days of the Operations Research program I got to teach a lot. When I moved up in the hierarchy and the OR Department got larger I didn't get to know the students as well as I would have liked. Working with the students was always a real pleasure, in fact in the early days I was almost the same age as the students. So I attended a lot of student parties and Wayne was always there.

WAYNE HUGHES: Wait a minute, what's the party connection?

JACK BORSTING: Wayne was a very thoughtful student who was always thinking about military applications and what he could do with the course material. Wayne, I think I had you in several Probability and Statistics courses.

WAYNE HUGHES: Yes. You did.

JACK BORSTING: We kept in touch over the years. And I believe one of the reasons Wayne is at the Postgraduate School is because of my recommending he return as a military professor.

LEE DICK: Before you start, just a couple of tidbits of information. First of all, Wayne is a former Navy Captain, a 1952 Naval Academy graduate, commanded the Minesweeper Hummingbird and Destroyer Morton, had some re-

ally outstanding OR tours including OP 96, the analysis division on Chief of Naval Operations staff, and at SACLANT. And then came here in 1979 as a faculty member. And I think his first, if I recall right, your first thesis student was Vice Admiral Pat Tracey. But after that, the thesis students kind of went downhill. A couple years later there was this kook that came up with an idea of doing a campaign analysis with the Seaplane full of fighters that he was a thesis advisor for.

WAYNE HUGHES: That's right. Lee Dick was my thesis student and maybe we collaborated on the most outrageous idea even I still think and Lee still thinks it is a good idea. It was a Seaplane out of which fighter aircraft flew. Max Platzer, the Chairman of the Aero Engineering Department at the time, swears that Lockheed Martin had patents on this idea and they were going to fly them out of a C-5. So it was a C-5 sized aircraft but it was a Navy Seaplane instead of a USAF land plane. And we probably would have gone from 700,000 pounds up to a million pounds because that was feasible. And about that point you want to go on the water because the weight was getting too big for a land plane. Max said it was possible to launch and land aircraft, and recover them in the air. And Lee did a careful cost effectiveness analysis. There is a lot of money in a carrier battle group so it's not too hard to show, expensive as a Seaplane would be to develop and procure, you could get the equivalent capability for less cost by going in the air. And of course you will get the combat capability on scene much more quickly. One could have built a missileer or a scout, and on and on. But a seaplane carrier was too far out of the box for the Navy or even the Air Force to pick up on. I still remember that effort fondly and the spectacularly careful work that Lee did on that thesis. Pat Tracey had a neat thesis, too. It was done on a hand held calculator. She "fired" a spread of missiles and calculated the probability of one or more hits. When the trajectory of the missiles is uncertain, when your own location is uncertain, and when there's an uncertainty of the target location. Neat little piece of work.

So much for that. Let me make a few more connections with Jack. Jack and Mike Sovereign and Ty Dedman, who was the Superintendent at that time, all walked into my office saying, "Why don't you come to work at the Postgraduate School?" And I'm sitting there thinking, "Throw me into that briar patch." Jack was one of my professors during my first quarter at NPS in 1962. He had a magic touch. His blackboard demonstrations were the most God-awful scrawl you ever imagined but you could just smell that he wanted to communicate, so he had this personal touch with me and I think the other students as well. I'd been out of the Naval Academy for ten years so getting back into math was tough for me. But as I got into it things got easier. Toward the end of the program we had some electives. I thought to myself, "What is it that I know the least about that I will never pick up again if I don't learn it here?" That was clearly statistics. So I signed up for advanced Statistics under Jack. And that was another treat. So there is a kind of mutual admiration society working.

JACK BORSTING: Let me interrupt for a moment. This was an elective course where the students presented papers and had an oral exam, one-on-one with me.

WAYNE HUGHES: Sort of like a Ph.D. defending a dissertation.

JACK BORSTING: I thought that would be a different experience for the students—how was it Wayne?

WAYNE HUGHES: I don't remember. I think I blacked out. I do remember Bob Read taught statistics then too. In those days nobody knew how to teach statistics except using proofs. The best thing about Bob was he was compassionate. Russ Richards came along later though I never had him in class. But I would like to mention Peyt Cunningham and Doc Torrance, who along with Jack, got the OA program off the ground. But they started in '51 and it was I think almost a two-man show. Peyton Cunningham was my thesis advisor.

I want to spend most of my time giving you a couple of anecdotes I think illustrate of what it was like to be a Fleet Analyst back in "the good old days". I'm going to emphasize the fleet side rather than the Washington side because I think we all feel that we need to get our roots back in the operating side under the philosophy that there is a war on now. So let's go

out and observe the war and get data instead of building simulations and getting data from simulations. Let's go out and see what we can do to actually improve operations. We have some of the most challenging operations. What I call "peace making" is about as challenging as one can imagine. And what are the characteristics that are amenable to analysis and improvements that are comparable to ASW in World War II? Well one of them is surely, "if you can find them you can kill them". There is a lot to be learned from Koopman's Search Theory and all of the things that were done by Dan Wagner and his disciples in the development of search methodologies. We've got a very powerful mathematician named Guillermo Owen teamed with the Chairman of our Special Operations curriculum, in the Defense Analysis Department. And Guillermo and Gordon McCormack are looking at an algorithm to help search for unique and hard to find terrorists. Let's help prosecute the war on terrorism. That would be my editorial for the day.

I'm going to reminisce from here on out. I want to start by saying that one of the things I am proudest of is how I got into the Military Operations Research Society. I was invited to attend when I was at ASWFORLANT as a commander, a Captain selectee, and the MORS Symposium was going to be at Ft. Lee, Virginia which is just up the James River from Norfolk. I can't remember who invited me but it may have been Erv Kapos because there used to be a little cell of analytical interest that Bob Miller started that included a great submarine officer, Captain Frank Andrews. Frank had conducted the search for the Thresher after it went down, and later on had done a lot of things in acquisition. So there was this little cell of people who were promoting analysis at the tactical level and one of them may have been who put my name in for MORS. I want to tell you "who I invited" to my working group I still have the names because I kept the program. They included Mike Sovereign, Stu Starr, a Fellow of MORS famous at MITRE. Bernard Koopman came and delivered a charming, absolutely charming, paper on the limits of large scale and high powered simulations on a mathematically theoretical basis. John Kettelle was another one of my favorite people. John was always thinking a little out of the box.

JACK BORSTING: Did he have his lederhosen on?

WAYNE HUGHES: He could have. John teamed with Erv Kapos for awhile and had a company and I know them both and they're both dear friends. Also Staser Holcomb, who was then Executive Officer of the Saratoga. He is in the fleet you see. It just happened that the Saratoga was in port. I invited him to talk about the evolution of the CV concept. We were going from CVA's and CVS's to a combination where the ASW aircraft would fly off the same carriers as the fighter attack aircraft because we were running out of aircraft carriers.

JACK BORSTING: You mentioned Staser Holcomb. When did you get acquainted?

WAYNE HUGHES: He had a VS Squadron when I was on First Fleet Staff and we both lived in Coronado.

JACK BORSTING: He got crosswired with John Lehman when John came in.

WAYNE HUGHES: Which is much to Staser's credit.

JACK BORSTING: The Secretary of the Navy, but I won't comment on that. Staser's got an interesting part-time job now. He's working for Rumsfeld behind the scenes helping him screen high level flag officer appointments. Secretary Rumsfeld is approving the appointment of high level flags in all the services, and Staser is helping him screen these officers. Staser was Rumsfeld's military assistant when Rumsfeld was Secretary of Defense the first time. Rumsfeld called Staser back from retirement to help him. Staser is a graduate of the Naval Postgraduate School with a Master's in Nuclear Effects, not in Ops Research.

WAYNE HUGHES: He was an early member of the old OSD Systems Analysis with people like Stansfield Turner, Jerry Miller, and Bob Monroe and some other people who went on to high office. One of the things the Navy did right when McNamara was Secretary of Defense was take an "if you can't beat them, join them" attitude. We put some of our very best down there to talk turkey with the whiz kids of System Analysis in Alain Enthoven's shop when it was under Charles Hitch.

The other thing we did was create OP-96, and I've always thought that Alain Enthoven was smiling all the time we were building up an opposition, an analytical force to confront and confound the systems analysts in OSD. If you read what he wrote later, he said that he wanted the services to have their own analysis capability. And so we did, we built a strong analytical capability. In those early days that we did most of our fighting with the barons in the office of CNO and were much less effective at communicating with them than when we fought with OSD Systems Analysis because at least we talked the same language. If we went to OP-05, the Aviation community, who ran the Navy at the time, they just stared us down. The submariners always had some of the smartest people walking working in OP-31 who could make every analysis justify more nuclear submarines.

UNKNOWN: Later OP-02.

WAYNE HUGHES: That's right. And the surface Navy didn't know what they were doing but we were sympathetic because we thought they needed help. And for the logistics people we just did the analysis for them because they were hopeless. Until people like Tom Hughes came along, an OA grad. Tom became OP-04 later on and revolutionized their capability to do good logistical analysis.

JACK BORSTING: Wasn't Bud Zumwalt the first OP-96?

WAYNE HUGHES: Yes. And he was wonderful. You were talking earlier about how the size of the OR faculty grew when you were chairman. Well when Bud Zumwalt was the Director of OP-96 we started with 20 people. Ten officers and ten civilians. By the time he and I left two years later it had grown to 80. He was an empire builder. Bud Zumwalt was, I thought, a wonderful man. I will tell you one anecdote about my experiences there. I always felt like his office was open especially in the early days when there were only—we weren't even 20 because we hadn't filled out yet. So I felt like I could go into his office and tell him any damn thing I wanted to. Kind of like you telling Harold Brown what you thought of his approach to managing the Secretary of Defense office. I've forgotten what the subject was, but I told him he was wrong, absolutely wrong. And he listened patiently for five minutes while I explained carefully the illogic of his case. And then he took another five minutes and convinced me that I was wrong. I walked out of the office persuaded—he was a very persuasive guy—that I was wrong. When he was CNO of course he sent out Z-grams and he inflamed the hatred of a lot of senior admirals and a lot of senior petty officers. But I've always said if he could have worked with them one-on-one instead of sending out messages he could have built morale instead of causing the turmoil he did.

JACK BORSTING: Zumwalt was not an analyst by training, but he was still very good. I remember talking with him about the use of analysis when he was the head of OP-96. He said, "Well you know, to me it's not the end result of the study that's important. It's the understanding of the assumptions and understanding what went on in the model and then what you got in the end." He said, "You might not do what the model told you but you learned so much more about the process you were studying because of the analysis." I still remember Bud Zumwalt in the early days of OP-96 expressing his view about the use of analysis.

WAYNE HUGHES: We had a series of the Navy's best and brightest in OP-96 in 1973 when I came back as the deputy; Admiral Zumwalt was now the CNO. He'd gone to Vietnam and had a successful tour over there. At a very young age, he was leap-frogged up to become the CNO. Harry Train was my boss; Staser Holcomb came in to relieve him. They had completely different styles, but both of them were wonderful men to work for. And the admin officer for both of them was a guy named Vernon Clark. To this day Admiral Clark says that his experience in OP-96 revolutionized his whole way of thinking and changed his life. It was that significant, the impact we had on the Navy. In fact, I used to work very long hours because I thought we were saving the Navy from itself. In some ways that was true and some ways we were kidding ourselves. Any event, it was a heady time.

I would like to shift to the fleet side for five or ten minutes, because I promised you I would. When I was at ASWFORLANT staff,

Zumwalt was the CNO. And one of his fervent desires was a sea control ship. We should have built it, folks. It would have saved us a lot of development time later when we brought along the LHA and LHD. It was actually conceived as smaller than an LPH, which was 18,000 tons. The idea was that it would be a mid-ocean escort for convoys because we really didn't have a way to give them air cover. It was having a lot of trouble with OPTEVFOR in its sea trials because the guy in charge of OPTEVFOR didn't believe in it. In fact, a lot of people in the Navy didn't believe in it. So it was taken away from OPTEVFOR and given to Admiral Fred Bennett who was COMASWFORLANT when I arrived. And he gave the problem to me to design the exercise which would test it at sea because I was the assistant chief of staff for analysis. Soon I'm doing a reasonable job of creating a rigorous plan to run the test ship with its ASW helicopters and carriers through a whole bunch of submarines and fend off low-level air attacks because that was the vision for it, low intensity attacks. But mainly it was supposed to contribute to protecting the convoy from the large Soviet submarine force. I'd been working on it for perhaps a week when Admiral Bennett called me in and said, "SUBLANT wants you to add two submarines to test their concept of the SSN in direct support of the submarine, nuclear convoy." So the purity of the test is now evaporating. Then a couple of days later he called me in and said that we have this new surface ship with a tactical towed array in the USS Patterson and I'd like to test that in the same experiment. So the analytical purity is getting to be out of hand. I took a piece of lined paper, cross hatched paper, and did an arrangement of the convoy and the Guam, which was the surrogate sea control ship, and two submarines and the Patterson with its towed array and positioned them in different locations and then called real living submariners in and said "Okay, you don't know what the formation is but you hear the noise of a surface ship here or here. Now, what will you do?" Just professional judgment of commanding officers of submarines and I'm over simplifying the process that we went through in arranging the formation. But the upshot of it was that they would hear the Guam first and they would try and get through the Patterson which would be the next noisiest and as they approached they detected it from its screw noises. So that meant that they would move out and they would try to move in from the side where two submarines would kill them and so on and so forth. The formation was a great work of art. No computer simulation, none of that stuff. It was enormously visible and understandable with a lot of hands on professional advice of operators including me because by then I'd had command of a destroyer and I'd grown up working in Anti-Submarine Warfare (ASW). We went to sea, and there were some crazy things that happened out there, but the long and the short of it is the task force commander, who was a flag officer, also didn't believe in the sea control ship and he didn't really operate the helicopters as I thought they should be operated. So the test of the sea control ship was inconclusive. However, the test of the SSNs escort could be deemed a failure because it became apparent to the submariners as well as everybody else that you had to give them "no attack zones" and that meant we had a mess when trying to prosecute a submarine. You really wanted to be able to say if you found a submarine you had weapons free, you didn't have to worry about hitting your own submarine escort. The submariners decided they wanted to protect more jazzy things than commercial convoys and military convoys anyway. So they abandoned the idea of tying SSNs to boring convoys and they went off and operated with carriers which made a lot more sense because the carriers move fast unlike the convoy and the nuclear submarines moved fast which was pretty good for complimentary operations. The Patterson array was the most interesting thing of all. Every submarine was getting detected by it. Yet this was only a simple prototype towed array. I got in a helicopter and flew over to the Patterson. And here is the captain sitting on the bridge. The captain ought to be in CIC because that's where the information is and that's where you fight the ship but it was not yet SOP for the commanding officer to fight the ship in CIC. And so he was sitting on the bridge and it was probably just as well because he was a political science type of guy and didn't know much about technology anyway. Still, he

knew he had something really magical. I went into CIC and here are the sound powered phone lines going to a talker with a headset on and he's getting a message from somewhere aft about submarine detections, ranges and bearings. Next they led me back to the fantail and here is this hokey arrangement of the towed array tail streaming from the rear of the ship. And all kinds of wires coming out of that tail led up to the little helicopter hangar where there were a lot of civilian scientists reading the reports from the tail. When they got a detection, they'd huddle around the oscilloscope and then say "Yeah, yeah, that's one". They sent the sound powered phone reports to the CIC and CIC sent a message back to the flagship.

I'm trying to describe a situation where if you really have something that's a breakthrough, you know it. And you don't have to have the thing analyzed statistically to the gnat's eyebrow before you take it to sea and test it. If it's a winner you will know it and you don't have to do a whole hell of a lot of analysis. I came back and reported: (1) the incompleteness of the sea control ship test; (2) the folly of using an SSN escort anywhere (near a formation, near meaning 15 or 20 miles from the formation); and, (3) the fact that the Patterson was going to be revolutionary. In it I reported that the Patterson's array was detecting our own submarines. These are quieted American submarines who aren't supposed to be detectable by anything at that range. The Chief of Staff was a nuclear submariner and he said, "You can't say that. That can't be true." So I took it out of the report and told Admiral Bennett verbally that not only was it detecting all the Soviet submarines but it was even detecting American submarines. And the upshot of that was the tactical array program took off. I had another story or two, but let me pause. Maybe it's time for you to start asking questions here. Chuck?

CHUCK WERCHADO: I'd like to ask this of both of you because you both touched on it at one time or another. I've been digging through some of the old files in my office and my predecessor's predecessor, Art Pennington, fought this good fight in the late '70's, asked whether we should keep building large CVNs or whether we should build what were called then a CVV. Since everything happens cyclically in the Pentagon we're now again looking at a Wasp Class ship sized carrier or another CVN. Do you guys in your vast experience, have you come to any conclusions on the efficacy of an all big deck carrier or mixed large and small carriers?

WAYNE HUGHES: Half of my life was spent watching the debate over nuclear versus conventional and big versus small, shall I go first?

JACK BORSTING: You are going first.

WAYNE HUGHES: The year is 1979; I'm working for the Undersecretary of the Navy about the time Mike and Jack are coming in and talking me into going to Monterey. And the Congress can't make up its mind; the two houses are split between a nuclear powered CVN and a conventionally powered large deck carrier. The little carrier will come into this, and I'll describe how. So they do what they always do when they can't make up their minds, they commission a study. Six months to do it. The Senate, the Secretary of Defense, and the Secretary of the Navy are favorably disposed towards a conventional CV. But the CNO, Admiral Tom Hayward, was hard over that the CVN was the right answer. The director of OP-96 at the time was a fellow named Carl Trost, later CNO. SecNav Claytor told Woolsey that he personally was to follow this study like a hawk to make sure that it was honestly done. Woolsey told Hughes to follow this study like a hawk to make sure it was honestly done. The CNO, Hayward, gave it to Trost and Trost gave it to CNA and I can confirm everything I am telling you because at CNA at the time was Bruce Powers who comes out here to NPS every winter to help teach campaign analysis. But at the time, what I am telling you was a surmise. It was just a good guess.

They did the study in an amazingly short time, in like six weeks. That meant it couldn't be as sophisticated as you might want otherwise. I'll explain what that means later. CNA and Trost came back and delivered the study and copy number one came to my office and I immediately took it without opening it to give it to Jim Woolsey. The CVV was a mid-size carrier of about 35,000 tons that could only fly STOVL aircraft. Doug Mow was the STOVL

aircraft (the Harrier aircraft) project officer. This was the AV8B and we had AV8As at the time and this was going to be the updated version. It was not a bad aircraft within its limited range. Doug Mow came running, waving the study, and saying, "Look Wayne, the study proves that the little carrier with Harriers is the only way to go." Well, I couldn't believe that Tom Hayward would send such a thing forward. Thirty minutes later somebody else came into my office saying, "Look Wayne, the study proves that the CVN is the only way to go." Thirty minutes later a known partisan of the CV came into my office saying, "Boy this is really impressive. It shows that the CV is the only way to go." So I went into the Undersecretary's office and I said, "Can I borrow that back?" I read the study and it all came clear. At least two out of the seven scenarios explored favored each of the three candidates. So if you believe the kind of war that you wanted to believe was the one that was going to be fought, then your candidate won. Now, that's ground truth folks. If there was a clear-cut answer we would have known 20 years earlier that the CVN or the CV was the best and whether or not a small deck carrier bigger than a sea control ship but smaller than an LHA or an LHD with STOVL aircraft was a promising solution. At that time, I was convinced that the CVN was the right solution for carriers, even though it cost about 25% more than a CV. A carrier is not a weapons system. You have to put aircraft on it. The aircraft cost as much as the carrier. By definition that's going to be a suite of the 90 aircraft whether it is a CVN or a CV. So already you halve the difference to 12%. We haven't operated anything yet. If you pulled in operating costs and you go the way we've been going with a 40-year lifetime, then you need to operate the thing. The operating cost, whether it's a CVN or a CV, is about 4% per year of the procurement cost. And the operating cost of the aircraft is 9% of 10% per year of the procurement cost of the air wing. So now we are down in the range of 2 or 3% difference in life cycle cost and we haven't even bought a second suite of aircraft yet. So if you're talking about a 40-year life, two generations of aircraft, procured and operated, then the 25% premium you pay for CVN nuclear power is now lost in the noise. Anybody will probably agree that the flexibility that you get by having nuclear power is well worth the difference.

Where are we now? Well, I personally think some of you know that I am a small combatant fan because of the new littoral warfare environment with the potential to be surprised and ambushed in those waters. I believe we gotta have air capability but we also gotta have a lot of fire power in shore and one way to develop the air capability would be to have a small aircraft carrier. The analog is the CVE, the World War II CVE, which by the way was about 10,000 to 15,000 tons in displacement. Functionally different from the CVN, operationally envisaged as supporting the inshore operation just like a CVE did. You can't have a "CVE" with modern CTOL aircraft which tend to be big. But you can have STOVL and UAVs. If you believe in the future of UAVs, which are already here, then maybe you can exploit the potential of small aircraft carriers. And so if I had my way I would be exploring a ship of about 10,000 tons that is air capable for the special kinds of aircraft. Vertical, helicopters, short take off marine version of the F-35, UAVs and UCAVs. And it all goes back to the sea control ship. If we'd have built some then we would be that far along in knowing what the potential was for this companion, this complement to the big deck. Big deck carriers are the most efficient way to carry firepower to sea but you can't have very many of them especially in this day and age. If we want to be able to spread our air capability, and we must, in more locations then it seems to me that's one way to do it.

Long answer, I know you knew this. Jack, what would you like to add?

JACK BORSTING: Not much to add but let me ask, would most of you agree with what Wayne just said? What he is basically saying is that it's scenario dependent. And that it makes a lot of sense to have it scenario dependent, and you probably have got to keep looking at different scenarios because of the various types of wars we're going to fight in the future.

UNKNOWN: Does that answer drive you to a solution that's common across all scenarios so that you're ready for whatever the next scenario is? You know, a little bit of everything?

JACK BORSTING: Rumsfeld and company are trying to build future capabilities. If you have capabilities, you can adjust to various threats. An example would be the Army's Future Combat System (FCS). The FCS is very network centric and will be able to adjust to different threats, urban warfare, et cetera and centralized warfare. So much depends on what you think is the future threat. You've got to have the capabilities to answer the many different threats we will face in the future.

WAYNE HUGHES: A good question, I forgot to mention, I told you the sea-based air platform study was done in an awful hurry. What it didn't do was look at mixes. I thought then and I think now that the sophisticated answer would be a mix. CVNs would be suboptimal in some roles but optimal in others. The STOVL aircraft, the small carrier would have been preferable in shore, for fast turn around, intense delivery kinds of situations where you expect to lose a lot of the aircraft. A mix would have been the sophisticated answer but they didn't have time to do it.

UNKNOWN: I must admit to being terribly confused by this. This friend was arguing recently about capability based planning versus whatever else we were doing because I don't understand how you can talk about capabilities without talking about environments or scenarios in which those capabilities are going to be employed. So I don't understand what this new argument is about capability based planning, which is very different from whatever we've been doing in the past. Can you help me with that?

LEE DICK: Chuck can really address it too, but we're basing all these capabilities on a myriad of scenarios. We have the 12 key sets that we're looking at, that they're both mid-term and long term. And then we're backing that up with the baseline security postures, the little vignettes, there is up to 25 of those now. So we are very scenario rich in which we are applying the capabilities against.

UNKNOWN: Well is that any different than what we've been doing for years? Haven't we always argued that we need is a robust set of scenarios?

LEE DICK: We never had the capabilities to develop the baselines, put them on a shelf and then pull them off and do our quick turn experiments.

UNKNOWN: I think the key term is uncertainty. Because in the criticism now, you know I'm new to the game but the criticism has been the past has been devoted to the most likely scenario. After September 11 no one can define what the most likely scenario is. So it requires a look across a wide range of scenarios to respond to uncertainty, which is why the systems you buy have to have multiple capabilities to respond to the multiple environments. When attempts to move in that direction occurred they failed, no one liked them, no one thought they were realistic, et cetera, so the desire now is to have this large scenario set that Lee was talking about that illustrate the current capabilities in these realms of uncertainty that they want us to be able to respond to.

LEE DICK: And also it's not just a wide range of scenarios but that scenario told you what the C-day, I-day, D-day was, whether there'd be nuke or non-nuke use. Now if you look at the new ones from policy it says here's the range of parameters, we're going to go fight Iran, okay. Here's most likely warning, here's worst case warning, here's best case warning. Also, here's most likely, here's worst case, so you have a scalable parameter set for each of the variables in the scenario. So you're not designing against a point solution, you're designing against a range of problems.

UNKNOWN: I have to stand up and say that really isn't any different than what we've always been talking about as good analysis. We have always said we need multiple scenarios; we need to test the system to get the variety of circumstances.

UNKNOWN: I think the change is the Senior Leadership Guide.

UNKNOWN: I just heard what you said. I work in FCS right now and we have one lousy scenario. And they're making million dollar decisions for what's going into the FCS on one lousy scenario. So I don't know what you guys are getting down there.

UNKNOWN: No, it's a choice of the United States Army because they have only one BCT scenario that they can use.

UNKNOWN: You know, they might be telling you something.

UNKNOWN: No, seriously. The strategic planning guide that says you shall size your forces against a combination of one four two one. There's no excuse to be looking at one scenario anymore.

JACK BORSTING: This is not really a heritage topic. **{Laughter}**

GENE VISCO: Maybe it is because what they are saying to us is we did a lousy job for the last 40 or 50 years.

JACK BORSTING: No, I don't think they're saying that, Gene. Let me put it very simply. I believe they are saying that most of the time most countries have looked to fight the next war based on the last war. And we don't want to do this as we face many possible new threats. Let's change the force structure so we have more flexibility and therefore more capabilities to do different things. That's how I understand it. Of course, many things are going to be the same, but you want to be able to think out of the box so you can develop new strategies.

Currently, I'm on the Army Science Board and am on a personnel, training and leadership panel for the FCS system and urban warfare. Hopefully we can explore new threats that we may face in future conflicts. Not just urban warfare as we know it now, but some other new threats that could develop. When we were fighting the Cold War things were easy. We had one opponent which we knew very well, and that made our defense very easy to structure. Once the Cold War stopped, we've got a mess, as Russ Ackoff would say. He liked to talk about messes when solving difficult OR problems. In defense, we've got a lot of messes around that we have to worry about for the future.

You've got to be able to train and get competent leaders down the chain because they are going to be out in the field with computers and information. Many successful things happened in Afghanistan because sharp computer enlisted types were able to ad hoc as things broke down. They could make the system work and get the job done. We've got to be able to get education and leadership in our training systems for officers and enlisted.

What time are we supposed to quit? About one? So we'd better lock up and—

UNKNOWN: Declare victory.